Distance, Speed, and Acceleration

Acceleration

Acceleration is also a rate of change. It is the rate of change in speed and is calculated by the ratio of the change in speed to the time interval that this change happened. It is how quickly something is speeding up or slowing down.

During constant acceleration, the same change in speed happens in each equal interval of time. When acceleration changes over time, we typically describe the object's average acceleration. For our purposes, acceleration is assumed to be constant, so the average acceleration is equal to the constant acceleration.

$a = a_{av} = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1}$	Where a = constant acceleration v_1 = initial position v_2 = final position Δt = total time taken to change speed

Common units for acceleration:

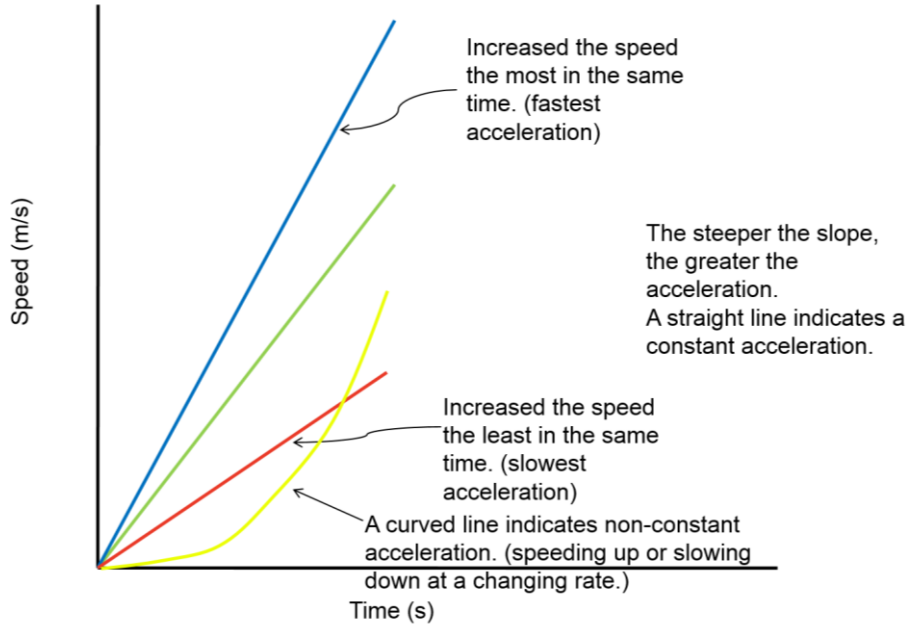
Ex. A person on their bike changes their speed from 10.0 m/s to 15.0 m/s in 15.2 s. What is the acceleration of the bike?

Ex. A car is traveling down the road when they see an obstruction. The person accelerates at -3.2 m/s^2 for 5.0 s until they stop. How fast was the car moving?

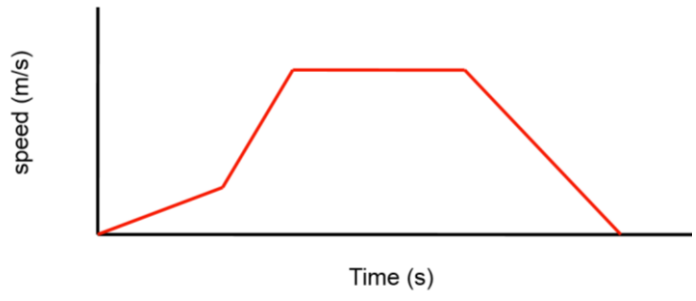
Speed-Time Graphs

We can represent acceleration with words (speeding up, slowing down), numbers (9.8 m/s^2) and we can also represent it visually with a graph. This can be done on a Speed-Time graph. On this type of graph, the slope give you the acceleration.

How?

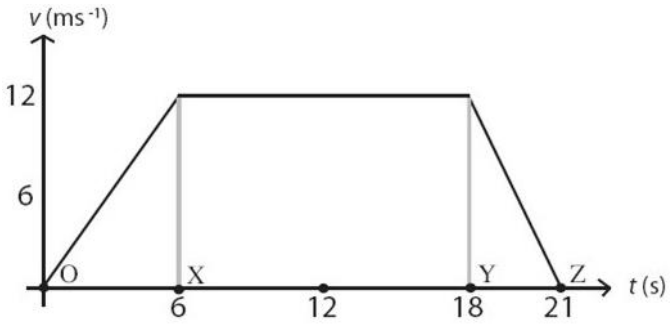


Ex. Describe the motion in the following graph.



While the slope of the graph gives you acceleration, the area under the curve gives you the distance travelled.

Ex. A moped's speed, as it is travelling between two traffic lights, is shown below.



a) When was the moped going a uniform velocity?

b) When was the moped accelerating? How can you tell?

c) When was the moped decelerating? How can you tell?

d) How fast was the moped going at 10 s?

e) Calculate the moped's acceleration between 18 and 21 s.

f) What was the distance between the traffic lights?

Instantaneous Speed

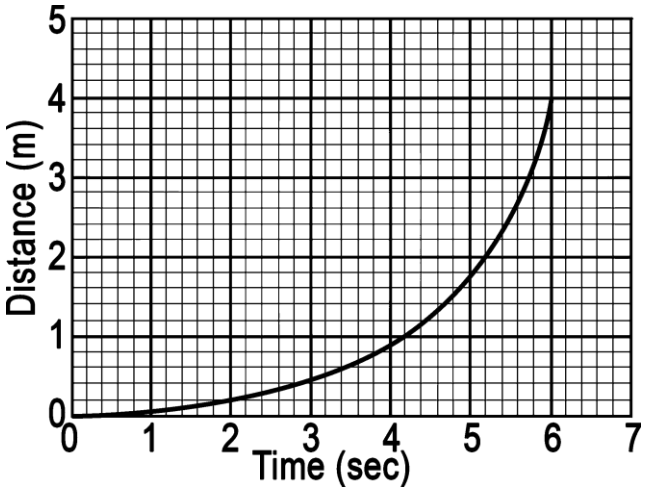
Instantaneous speed is the speed at a particular moment. Remember that it is unaffected by the speed from earlier or later in the trip.

For any object moving at a constant speed, the instantaneous speed is the same at any time and equals the constant speed.

If there is an acceleration, then this is not true, and the distance-time graph will not have a straight line. As such, if we were to take the slope, it would just find us the average speed and not the instantaneous speed.

To find the instantaneous speed with an acceleration present, we have to find the slope of the tangent line to the curve. A tangent is a straight line that just touches the curve at a point and represents the instantaneous slope of the line at that point.

Ex.



Find the speed of the object at:

a) 2 s

b) 4 s

c) 5.6 s